

Supplementary Information for

Tripole-like Antarctic sea ice pattern linked to remote forcing from the Indian Ocean and Maritime Continent

Weihan Ma^{1,2}, Xiaojun Yuan³, Yurong Hou^{1,2}, Kai Man^{1,2}, Yujie Miao^{1,2}, Li Zhang^{4,5*},
and Xichen Li^{6,7*}

¹Institute of Atmospheric Physics, Chinese Academy of Sciences, Beijing, China.

²University of Chinese Academy of Sciences, Beijing, China.

³Lamont-Doherty Earth Observatory of Columbia University, New York, NY, USA.

⁴Frontiers Science Center for Deep Ocean Multispheres and Earth System and Key Laboratory of Physical Oceanography/Academy of the Future Ocean, Ocean University of China, Qingdao, China.

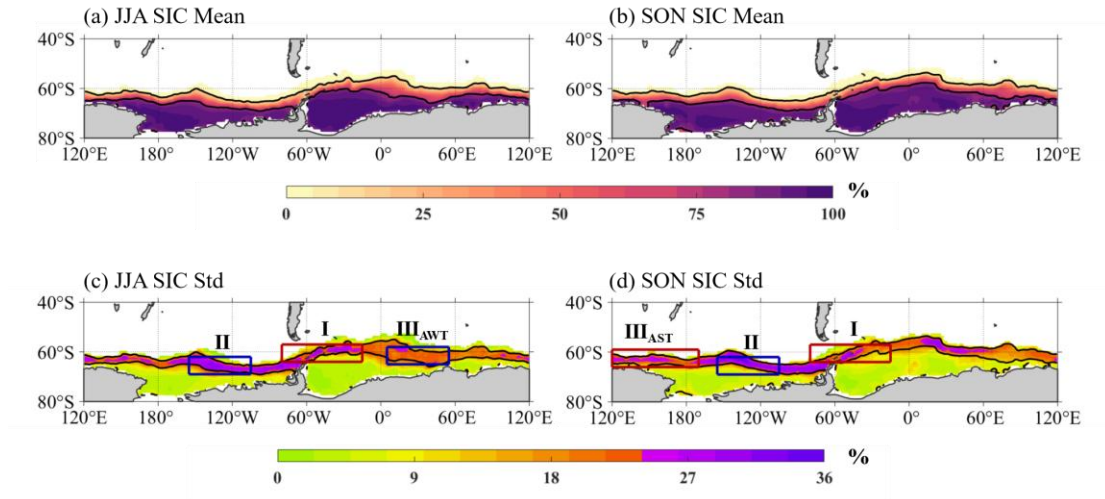
⁵Laoshan Laboratory, Qingdao, China.

⁶Institute of Ocean Research, School of Physics, Peking University, Beijing, China.

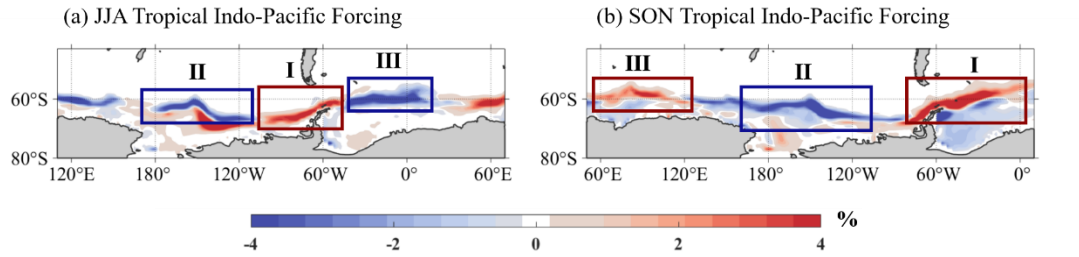
⁷Department of Atmospheric and Oceanic Sciences, School of Physics, Peking University, Beijing, China.

*Corresponding authors: Li Zhang (zhangli@ouc.edu.cn) and Xichen Li (xichenli@pku.edu.cn)

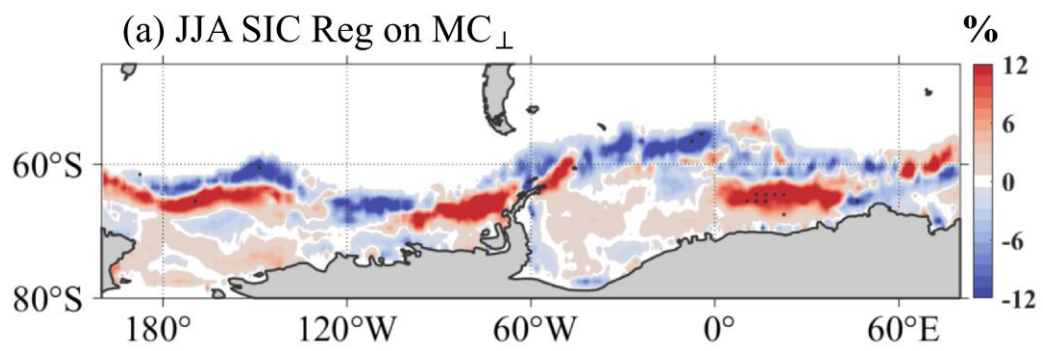
This supplementary information includes Figures S1-S6.



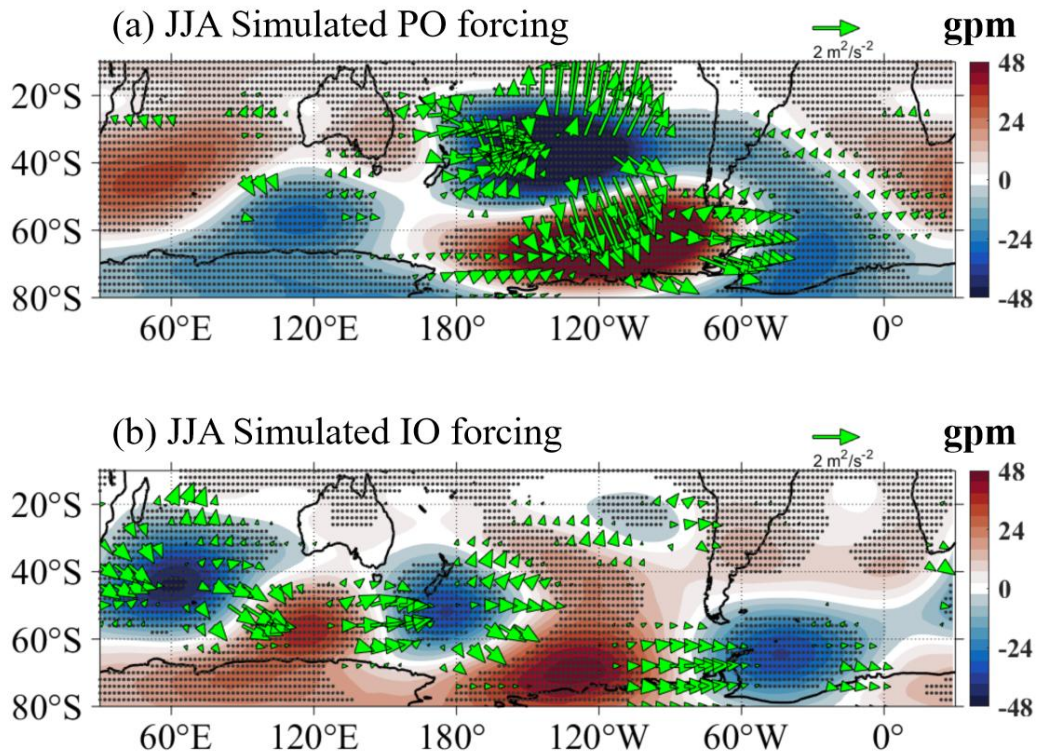
Supplementary Figure 1 | Antarctic sea ice variability during austral winter and spring. **a-b** SIC mean values (shading) and contours (10% and 80%) during JJA (a) and SON (b). **c-d** SIC standard deviation (std) during JJA (c) and SON (d). The 10% and 80% SIC (black contours) represent the transitional belts where the Antarctic sea ice exhibits the highest gradients (light shading in **a-b**) and the largest std (purple shading in **c-d**). Boxes I–III in **c-d** denote the locations of the three anomaly centers, consistent with those shown in **Fig. 1d, e**.



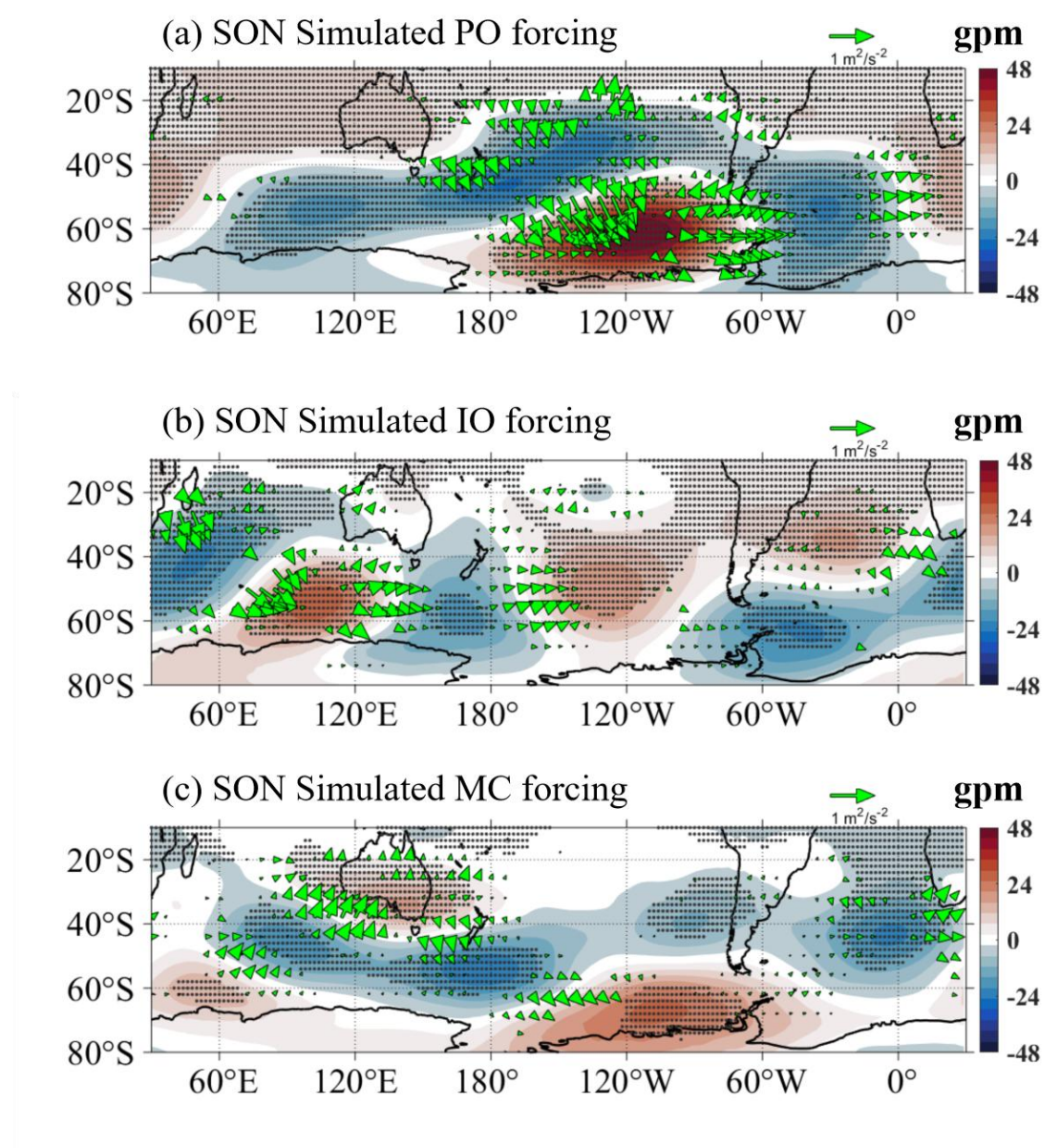
Supplementary Figure 2 | Simulated Antarctic sea ice tripole under the Indo-Pacific SST forcing. a-b Simulated response of SIC during JJA (**a**) and SON (**b**), obtained from the coupled CESM pacemaker experiments in which the Indo-Pacific SST anomalies are prescribed following regressions onto the AWT and AST indices (see “Pacemaker experiments” in Methods). The boxes I-III indicate the emerging wintertime tripole pattern (**a**) and springtime tripole pattern (**b**) in both simulation cases.



Supplementary Figure 3 | Sea ice response to the Maritime Continent during austral winter. a Partial regression of the SIC (shading) against the independent $MC_{\perp}$ index during JJA.

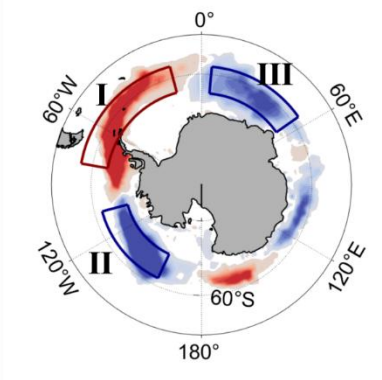


Supplementary Figure 4 | Simulated Rossby wave trains from the Indo-Pacific Oceans during austral winter. a-b Partial regressions of the simulated H500 (shading) and Plumb wave flux (arrows) against the independent PO_⊥ index (a) and IO_⊥ index (b) during JJA, based on the Community Atmosphere Model version 5 (CAM5) experiments (see “Atmospheric transient experiments” in Methods).

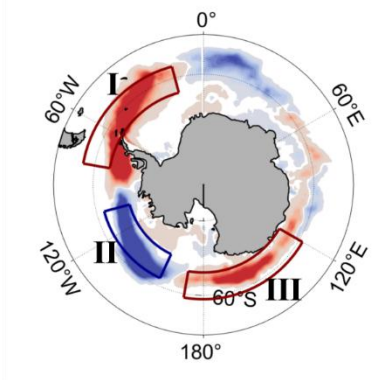


Supplementary Figure 5 | Simulated Rossby wave trains from the Indo-Pacific Oceans during austral spring. a-c Partial regressions of the simulated H500 (shading) and Plumb wave flux (arrows) against the independent PO_⊥ index (a), IO_⊥ index (b) and MC_⊥ index (c) during SON, based on the CAM5 experiments (see “Atmospheric transient experiments” in Methods).

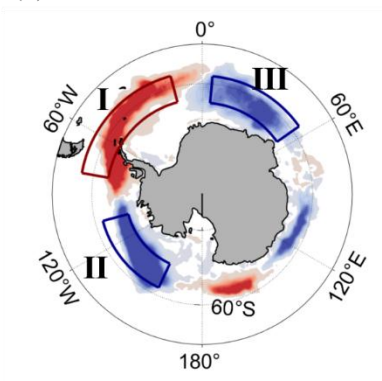
(a) NSIDC JJA EOF-1 24.5%



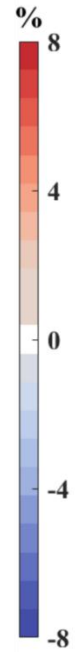
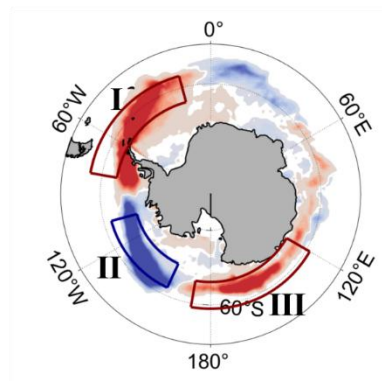
(b) NSIDC SON EOF-1 21.1%



(c) ERA5 JJA EOF-1 24.4%



(d) ERA5 SON EOF-1 21.8%



Supplementary Figure 6 | Antarctic sea ice tripole across the observational and reanalysis datasets. **a-b** First EOF mode of sea ice edge anomalies (30% sea ice concentration) (see “EOF analysis” in Methods) around Antarctica during JJA (**a**) and SON (**b**) in observational datasets from National Snow and Ice Data Center (NSIDC). **c-d** Same as panel **a-b**, but based on reanalysis datasets from the European Centre for Medium-Range Weather Forecasts Reanalysis version 5 (ERA5) during JJA (**c**) and SON (**d**) (see “Datasets” in Methods). The boxes I–III indicate the tripole-like sea ice patterns.